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ABSTRACT

This paper report the findings of the first phase of a multi-phased research project that is aimed at examining preservice teachers' development of science concepts when learning: (1) takes place at a distance, and (2) is facilitated by videoconferencing technology. The study builds on the work that was done by Lansdown (Lansdown, Blackwood, and Brandwien, 1971) and validated at Boston College (Trainor, 1978) and at Harvard University (Harvey, 1980) that demonstrated the validity, effectiveness and evaluative power of an investigation/colloquium approach to students' development of science concepts in a face-to-face learning environment. The pilot study investigated the use of the investigation/colloquium approach (a series of student-directed explorations with hands-on materials followed by colloquium discussions facilitated by an adult leader) by ten students at two sites connected by videoconferencing technology. Results of the pilot study, analyzed using standard qualitative analysis procedures, indicated that Vygotskian group socio-cultural learning (particularly the development of science concepts) could take place effectively when the groups are in separate locations connected by videoconferencing technology. (Contains 24 references and 6 tables.) (Author/AEF)

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Learning Science Concepts at a Distance in Preservice Teacher Education: Results of a Pilot Study

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Abstract

This paper will report the findings of the first phase of a multi-phased research project that is aimed at examining preservice teachers' development of science concepts when learning (a) takes place at a distance, and (b) is facilitated by videoconferencing technology. This study will build on the work that was done by Lansdown, (Lansdown, Blackwood, and Brandwien, 1971) and validated at Boston College (Trainor, 1978) and at Harvard University (Harvey, 1980) that demonstrated the validity, effectiveness and evaluative power of an investigation/colloquium approach to students' development of science concepts in a face-to-face learning environment. The pilot study investigated the use of the investigation/colloquium approach (a series of student-directed explorations with hands-on materials followed by colloquium discussions facilitated by an adult leader) by ten students at two sites connected by videoconferencing technology. Results of the pilot study, analyzed using standard qualitative analysis procedures, indicated that Vygotskian group socio-cultural learning (particularly the development of science concepts) could take place effectively when the groups are in separate locations connected by videoconferencing technology.

Introduction and Need for the Study

This paper reports the findings of a pilot study which was the first phase in a project designed to investigate and validate techniques for using videoconferencing technology to promote the development of preservice teachers' science concepts. The ultimate goal of this three-phased study is the development of a curriculum matrix (content, material, and procedures) that will facilitate science concept learning at a distance. The study will be used to examine the efficacy of using videoconferencing technologies to improve science concepts in preservice teachers by (a) supporting innovative course configurations that may increase preservice teachers' access to pedagogically sound science instruction, (b) extending professional collaboration between preservice and inservice teachers; and (c) promoting quality continuing education that is accessible and affordable.

The results of the Third International Mathematics and Science Survey (IEA, 1996; NSB, 1998) raised serious concerns about science education in the United States. The data collected from the TIMSS demonstrated that the U.S. science curriculum lacks focus and depth (NSB, 1998; Schmidt & Wang, 1999; Valverde & Schmidt, 1998). Schmidt and Wang (1999) stated:

One of the most salient and powerful policy implications from the TIMSS is the essential role of the curriculum in the teaching and learning of math and science. The TIMSS achievement results suggest a disturbing pattern: the relative standing of U. S. students compared with other countries declines from fourth to twelfth grade. The U.S. science curriculum over these same grade levels has been characterized as highly repetitive, lacking coherence, and not focusing on rigorous content as defined internationally. (online)

Schmidt and Wang suggested that the failure of the U. S. students in science may well be the consequence of "...the mile wide inch deep curriculum, the largest textbooks in the world, and a splintered vision of what children should learn about science." (online) They further noted that U.S. textbooks "...play a major role in the splintering or fragmenting that occurs in U. S. science education." (online) They argued that the problem with textbooks cannot be underemphasized since teachers in elementary or middle school who do not have strong science backgrounds view and teach science directly from the textbooks.

Research literature suggests that most U.S. elementary and middle school teachers lack the content knowledge and confidence needed to teach science (Berg, Huinker, & Neuman, 1993; Rice & Corboy, 1995) . According to Rutherford and Ahlgren (1990):

Few elementary school teachers have even a rudimentary education in science ... Unfortunately, such deficiencies have long been tolerated by the institutions that prepare teachers, the public bodies that license them, and the schools that hire them....

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A revised curriculum is needed in both the content and the delivery of preservice science courses if we are to prepare teachers who have a firm understanding of the basics of science (AAAS, 1994; Berg et al., 1993; Harris, 1993; Tolman & Campbell, 1991).

Measuring learner achievement has been a major focus of studies in interactive video-based learning (Moore, Thompson, Quigley, Clark and Goff , 1990; Payne, 1997). A vast body of research literature generally acknowledges that there is no significant difference in learner achievement between students who participate in instruction at a distance and students who participate in traditional settings. Yet, the validity of this body of research has been called into question (Cohen, Ebeling, & Kulik, 1981; Moore et al., 1990; Phipps & Merisotis, 1999; Russell, 1996; Schlosser & Anderson, 1994). Phipps and Merisotis, 1999 stated that there is rising evidence that much of the existing research that has examined student achievement in distance learning is weak and largely anecdotal.

Most research on distance learning has treated learner achievement as an all-inclusive term that does not distinguish between higher and lower level thinking skills. Vygotsky (1986) identified concept development as the ability to (a) form linkages between concepts without reference to concrete or sensory impressions, (b) verbally define the concept in abstract terms, and (c) apply the concept to new situations which must be considered in abstract terms. Clearly, learner achievement that is a measure of concept development as defined by Vygotsky is far different than learner achievement that is a measure of lower level cognitive skills such as the student's ability to identify, order, or compare lists of items.

This paper will report the findings of the first phase of a three-phase study that was conducted in March-April 2000. The participants included undergraduate students from College Misericordia's Teacher Education Program who were enrolled in a science methods class. A unit on waves was taught using the investigation/colloquium model. Half of the students participated from the videoconferencing facilities at College Misericordia (Dallas, PA) while the other half participated from King's College (Wilkes Barre, PA).

Preliminary findings suggest that preservice teachers can learn science concepts at a distance when connected by videoconferencing technology using the investigation/colloquium method of instruction. Other preliminary data offer insights into procedural changes for the second phase of the study which will take place in September of 2000.

Method

A considerable body of literature (e.g., Lenning & Ebbers, 1999; Moller, 1998; Mukhopadhyay, 1997; Palloff & Pratt; Stone & Sulino, 1997) has suggested that a key element in successful distance learning is the formation of a synthetic class relationship. A synthetic class relationship is one in which the students come together as one cohesive community of learners. In a successful distance synthetic class relationship, students feel and act as part of one group whose members just happen to be situated in various geographical locations. The verbal and nonverbal socio-cultural interactions evident in a synthetic class relationship are consonant with Vygotsky's emphasis on the socio-cultural aspect of concept development. This pilot study was conducted in the late spring of 2000. The study was designed to extract information from the socio-cultural elements in the learning environment by focusing on the patterns of interaction between and among participants during the colloquium segments of each videoconferencing session.

The research took place at a small, private, four-year college in Northeastern Pennsylvania and included a baseline assessment of the participants and four one-hour videoconferencing sessions. The study participants included 10 volunteer preservice education majors who had completed their core science requirements but had not yet fulfilled their science methods requirement. Five of the students participated from the college videoconferencing facilities and five students participated from a videoconferencing facility approximately 10 miles from the campus. Students were designated as being same-site or other-site, which was determined by the physical presence or absence of the instructor.

The instructor was a physics professor who has a background in science education, and regularly co-teaches the science methods courses with a teacher education faculty member. During the study the instructor was physically present at each site for two sessions. Additionally, an activity aide was present at the other site (i.e., remote) who simply handed out materials and did not interact with the students during the sessions.

The study consisted of a baseline assessment and investigation/colloquium-based lessons that were facilitated by videoconferencing technologies. The baseline assessment consisted of a short one-on-one interview of the participants to establish their baseline knowledge of waves. Participants were asked an open ended question (i.e., "What can you tell me about waves?"), and a follow up question (i.e., Is there anything more you can tell me?) The participants exhibited wave concept understanding below an upper elementary level.

The experimental sessions were comprised of four one-hour investigation/colloquium sessions that were delivered using videoconferencing technologies. The first three videoconferencing sessions began with the instructor introducing manipulable materials that would allow the participants to physically explore wave phenomena. The materials used were: (1) slinkies; (2) string telephones; (3) oven racks suspended by strings. After the instructor introduced the materials, the students were given ten minutes during which they engaged in hands-on investigations using the materials. At the end of the ten minutes of investigation, the instructor called both groups together to participate in a fifteen-minute colloquium. The colloquia were student-directed, with the instructor merely acting as a facilitor to the discussion. The purpose of the colloquia was to have the participants discuss their observations and attempt to verbally make sense of their investigations. Among other things the colloquium participants asked questions, gained insights from each other, and came up with new ideas about how further investigation may help them find answers to their questions. Following the colloquium the participants engaged in another ten minutes of hands-on investigation, which was again followed by a fifteen-minute colloquium. During the final week, the session structure remained the same (i.e., ten minutes of investigation followed by fifteen minutes of colloquium) however, the participants watched video segments that demonstrated wave concepts instead of working with manipulable materials.

All session were audiotaped and videotaped. Written transcriptions were made from the tapes. Colloquium statements were analyzed using Harvey's (1980) scoring scheme. Verbal interactivity was analyzed by numerical occurrences relative to the directionality of the statement. Each statement was coded as: (1) a response to a statement from either the same site or the other site; (2) a statement directed to either the same site or the other site.

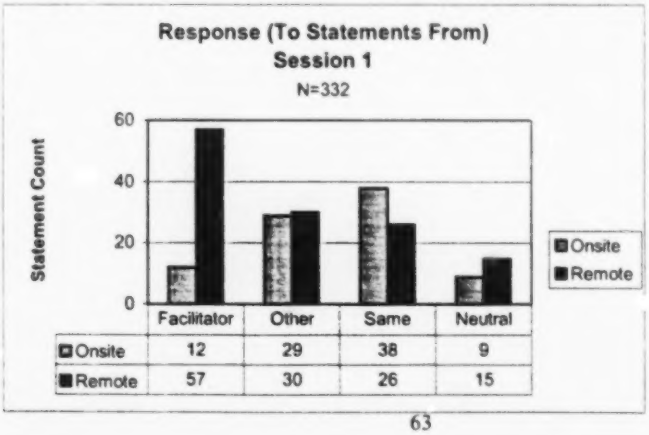
Results and Analysis

Informal analysis of the participants' statements from the colloquia associated with the hands-on investigations demonstrated that students at both the same-site as the facilitator and at the remote site developed higher-level concepts. The participants' statements were analyzed using Harvey's (1980) scheme, which is based on Vygotsky's levels of concept development. The statement analysis indicated an increase in students' higher level thinking statements (i.e., pre-concept) and a decrease in lower level thinking statements (i.e., complex) over the three sessions. In addition, the student's responses became more concise and focused as the sessions progressed and the total number of student statements decreased with each session.

Instructor (facilitator) statements also decreased over time which corresponded with a decrease in student statements directed to the instructor. Instructor statements accounted for 29% of the total statements during the first session and 8% of the statements in the final session. Total student statements (same-site and other-site) directed to the instructor (facilitator) decreased from 51 during the first session, to 26 during the second session, to one during the final session.

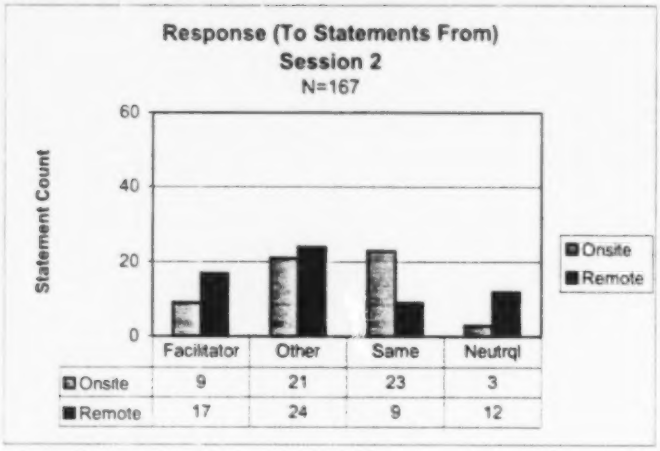
Extensive verbal interaction occurred both within sites and between sites, and the interactions between sites increased over the three colloquia. Figures 1 through 3 present the number and types of responses made by subjects during the three sessions to statements from the facilitator, from subjects at the other location, and from subjects at the same location. Figures 4 through 6 present the number and types of statements directed by subjects to the facilitator, to subjects at the other location, and to subjects at the same location.

Table 1



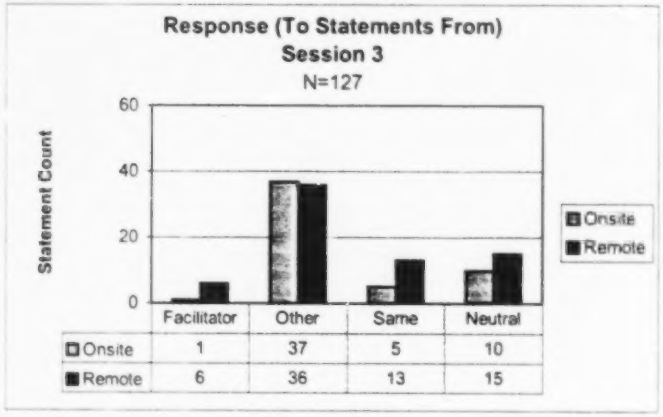
	Facilitator	Other	Same	Neutral
Onsite	12	29	38	9
Remote	57	30	26	15

Table 2

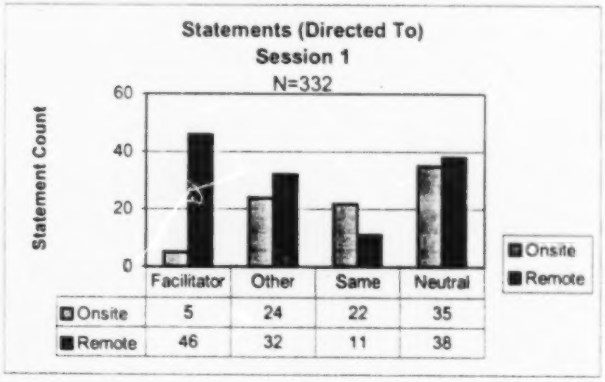


	Facilitator	Other	Same	Neutrql
Onsite	9	21	23	3
Remote	17	24	9	12

Table 3

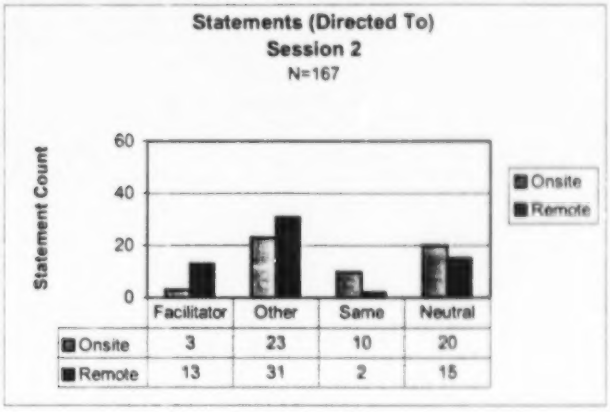


	Facilitator	Other	Same	Neutral
Onsite	1	37	5	10
Remote	6	36	13	15



	Facilitator	Other	Same	Neutral
Onsite	5	24	22	35
Remote	46	32	11	38

Table 4



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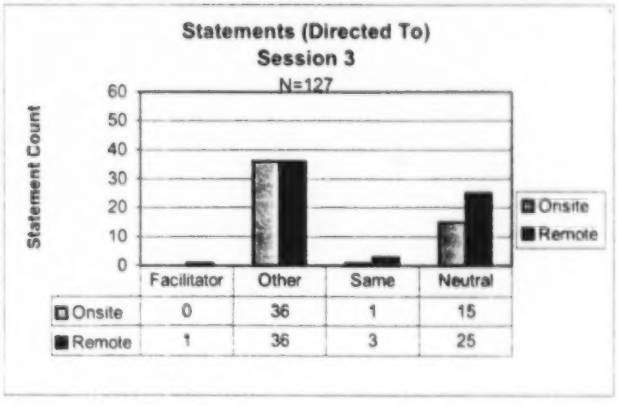

Table 6

Discussion

The main emphases of science reform appear to be consistent with Vygotsky's socio-cultural theory of learning. The initial findings of this study suggest that the unique characteristics of videoconferencing technology make it a promising medium for delivery of effective Vygotskian-based learning in teacher education. All indicators point to videoconferencing at both the studio and desktop level becoming more generally accessible, and therefore, more likely to be used in educational settings involving K-12 students.

Recently, the validity and reliability of much of the existing research on the use of videoconferencing has been called into question. This has left a paucity of reliable research that explains the phenomena related to teaching and learning via videoconferencing. Many critical questions remain unanswered. Further, the development of higher level thinking skills and concept formation is at the heart of the science reform recommendations; yet the existing body of literature fails to make a distinction between higher and lower level thinking skills as they relate to student achievement.

Videoconferencing and other distance technologies alter the classroom dynamics sufficiently to warrant a cohesive research effort that examines the mediating factors that affect student concept development when learning takes place at a distance. The results of this study suggest that the investigation/colloquium approach, which has proven successful in the traditional classroom, may be useful in videoconferencing learning. The final two phases of this research project will further test and refine the preliminary findings of this study.

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